ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
June2024 Vol. 34

Clinical Evaluation of the Effect of two Resilient Attachments Retaining Mandibular Over-Denture Supported by Implant and Natural Tooth on the Supporting Structures

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Aim: This study aimed to assess the effect of two resilient attachments used for retention of mandibular over-denture supported by an implant and a natural tooth on the supporting structures throughout a one-year follow-up period.
Materials and methods: Fourteen patients with maxillary completely edentulous arches and only one standing natural mandibular canine were selected. Each patient received a dental implant with 10.5 mm length and 3.8 mm diameter at the canine region of the contralateral side of the mandible. The patients were divided into two groups according to the type of attachment used (n=7); BC group included patients who received mandibular over-dentures retained by bar clip attachment supported by an implant on one side and a natural tooth on the other side. BS group involved patients who received a mandibular implant splinted to the natural canine by bar joint attachment utilizing soft liner material. The patients of both groups were rehabilitated with conventional maxillary complete dentures. Clinical and radiographic assessment were performed immediately after over-denture delivery, six and twelve months from denture insertion. Clinical evaluation involved gingival index. Radiographic evaluation included measuring mesial, distal, buccal and lingual bone height differences.
Results: BC group recorded significantly higher bone loss compared to BS group around both dental implants and natural teeth.
Conclusion: Considering the limitations of this study, it could be concluded that soft liner retained over-dentures are more effective in decreasing bone resorption around the implants and natural teeth compared to clip retained over-dentures.

Keywords: Implant, Bar retained over-denture, clip attachment, resilient liner, bone height.

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Introduction

Conventional dentures have been the primary treatment option for rehabilitation of completely edentulous patients. Although most patients are satisfied with this treatment yet, a considerable number of patients encountered difficulties in adapting to denture wearing and expressed dissatisfaction. Patients reported problems including difficulty in mastication, pain, and discomfort associated with denture wearing which are crucial concerns as a direct link has been reported between impaired oral health and poor quality of life.[1]

Numerous elderly patients have significantly diminished dentition because of periodontal disease or caries, rendering the construction of fixed prostheses unfeasible.[2] In these situations, an over-denture supported or retained by one or more remaining natural teeth, roots, or dental implants is a practical alternative. Over-dentures offer the benefits of decreasing the rate of bone resorption of the residual ridge, preservation of natural teeth and sensory feedback of the periodontal mechanoreceptors, enhanced stability, support and improved chewing efficiency compared to traditional complete dentures.[3]

Osseointegrated implants have broadened the treatment options available for edentulous patients. Implant-supported and implant-retained prostheses are now commonly used as an alternative to traditional complete dentures. Patients reported positive outcomes regarding masticatory satisfaction and quality of life after receiving implant-retained prostheses. [4]

Single standing tooth is a challenging situation for use as an over-denture abutment due to excessive stress concentration which leads to torque on the natural tooth in addition to lack of bilateral stabilization that may cause tooth mobility and hence short-term serviceability. One of the considerable treatment options for such situation is the use an implant on the contralateral side splinted to the natural tooth for cross arch stabilization and support. [5]

It has been reported that splinting implants to natural teeth is an affordable and effective solution for treating partially edentulous patients with the advantage of maintaining proprioception provided by natural abutment teeth. The unique proprioception provided by the periodontal ligament can prevent occlusal overload in tooth implant-supported prostheses as both teeth and implants share the occlusal load thus providing more favorable stress distribution. Moreover, the number of implant abutments needed for a prosthesis is reduced, exodontia, bone augmentation procedures or additional risks that are associated with implant placement can be avoided. [6-8] On the other hand, this treatment modality might be associated with some drawbacks such as compromised osseointegration, periapical infection, tooth intrusion, cementation failure of prostheses, and loosening of screws. In an attempt to enhance the clinical outcome of this treatment option, it has been recommended to avoid using short implants or selecting patients with poor bone quality. [9]

Compared to solitary anchors, the use of bar attachments provided splinting, improved stress distribution among the abutments, enhanced retention with fewer clinical complications. However, soft tissue proliferation in the relief spaces around the bar attachments, plaque accumulation, microbial colonization with subsequent peri-implantitis and bone loss are among the shortcomings of bar attachments. In addition to the difficulty in maintaining adequate oral hygiene underneath the bar and around the abutments. [10]

It has been reported that soft liners are viable as long-term attachments over bars in implant retained over-dentures. Soft liners offer numerous benefits, such as minimal wear, effective obturation of space around the bar,

enhanced patient satisfaction and better distribution of chewing forces. [10-12]

However, few clinical studies focused on the effect of the type of attachment used with splinted implants to natural teeth on the supporting structures.[5] Therefore, the objective of this study was to assess the impact of two distinct types of resilient bar attachments used for retention of mandibular over-denture supported by an implant and a natural tooth clinically and radiographically on the supporting structures throughout a one-year follow-up period.

The tested null hypothesis was that there would be no difference between using a clip or resilient liner to retain mandibular bar over-denture supported by an implant and a natural tooth on the supporting structures after a one-year follow-up period.

Materials and methods

Sample size analysis

The sample size was determined using G*power version 3.1.9.2 for sample size analysis, with a significance level of $\alpha = 0.05$ and a power of 80%, resulting in a calculated sample size of seven patients for each group based on a previous study.[13]

Patients' selection and enrollment

Fourteen male patients with complete edentulism were selected from the Oral and Maxillofacial Prosthodontic Department Clinic, Faculty of Dentistry, Ain Shams University. The patients were selected according to the following criteria: age range from 50-60 years old patients with a completely edentulous maxillary arch and only one mandibular standing canine. Preoperative radiographic examination revealed height of bone greater than 10 mm and width of the crestal bone greater than 5 mm in the anterior region of the mandible. Moreover, the remaining bone and mucosa exhibited no signs of pathology, bony irregularities, or neoplastic growths. The selected canines were characterized by having favorable periodontal condition with no mobility, with adequate zone of attached gingivae of at least 2 mm, root length more than 12 mm and free from calcification.

Exclusion Criteria involved blood dyscrasias, bleeding disorders, severe vascular heart disease, systemic diseases affecting bone metabolism and abnormal jaw relationship (Angle class II or III).

Patients selected for the study were well informed about the surgical and rehabilitation procedures. The study was conducted in compliance with the Helsinki guidelines for ethics and received approval from the local ethical review board to ensure the participants' safety well-being. Following an explanation of the study procedures, all enrolled participants provided their signature on an informed consent.

Prosthetic and surgical procedures

Alginate impressions were made for the maxillary and mandibular ridges and poured into dental stone to attain the study models. The diagnostic stone models were then mounted on a mean value articulator after recording the jaw relationship. The relation between the maxillary and mandibular ridges was inspected to ensure the presence of adequate inter-arch distance for attachment placement.

Canine abutment preparation

The mandibular canine was endodontically treated and prepared as dome shaped with a15-degree inclination in all surfaces except the buccal surface with a 30-degree inclination, reduced in height so that it could act as abutment support for the over-denture. The recess for the post was prepared by using a Gates Glidden drill for removal of the gutta percha and to extend into the root canal for a length of 8 mm leaving a minimum of 5 mm of apical gutta percha.

Unimetric drill (Dentsply,UK) was used for post recess preparation . A rubber stopper was inserted in the drill and kept at a length of 8 mm for standardizing the depth of the post recess in both study groups. The 8 mm were measured from the contact between the rubber stopper and the higher portion of the tooth structure.

Construction of maxillary and mandibular conventional dentures

All patients received complete dentures fabricated following the conventional procedures. The dentures were constructed using semi-anatomic acrylic resin artificial teeth following a bilateral balanced occlusal scheme. Patients were frequently recalled for follow-up to ensure their satisfaction with the dentures.

Construction of the surgical stent

Radiographic stent was fabricated for each patient by duplicating the mandibular denture in clear acrylic resin. A gutta percha radiopaque marker was placed at the proposed implant site within the stent. The radiographic stent was inserted intra-orally and cone-beam CT (CBCT) was obtained to evaluate bone quantity and quality and to detect the location of the prospective implant site in the canine region (Fig.1A). The gutta percha was removed from the radiographic stent to convert it into a surgical one. The surgical stent was properly seated on the mandibular residual ridge. The position of the prospective implant was marked on the mucosa by a marker in the canine region and the stent was then removed.

A sharp long mucoperiosteal horizontal incision was made slightly labial to the crest of the residual ridge at the anterior region of the mandible and extended 1cm bilaterally distal to the mental foramen to expose a broad area of the ridge with minimal damage to the tissues. Two small oblique incisions were then made in a distobuccal direction at each end of the horizontal incision. A mucoperiosteal elevator was used to reflect the flap lingually and buccally. The entire bone preparation was performed with three drills of increasing diameter. A pilot drill 2.3 mm in diameter was used, followed by 2.8mm and 3.2mm diameter drills using internal and external irrigation, to prevent overheating of the bone. Direction and parallelism were checked by placing the unimetric drill in the prepared root canal of the natural canine to act as a paralleling rod.

Insertion of the fixtures

Self-tapping root form screw-vent titanium dental implants (Biohorizon implant system, USA) with dimensions of 3.8 mm in diameter and 10.5 mm in length were chosen. The implant was inserted into the prepared site until resistance was encountered. Further tightening and stability control of the fixture were achieved using the hex driver and hand wrench from the surgical kit. The implant was finally screwed into place until it was 0.5–1 mm below the bone level.

The operation area was thoroughly irrigated with saline to remove any remnants. The muco-periosteal flap was then repositioned, excess soft tissue was removed, and the flap was secured by interrupted sutures. The sutures were extended throughout the whole incision and stopped 1mm away from the implant site. The coronal part of the prepared root canal of the natural canine was sealed with teflon and glass ionomer restoration till the definitive prosthetic stage.

The patient was instructed to use liquid and soft diet for the first week and motivated to maintain good oral hygiene. Removal of the sutures was performed seven days post-surgery. Patients were instructed not to impose any load on the sites of fixtures for the first 2 weeks after fixture installation. After 2 weeks, the patient was allowed to wear his denture after relining the mandibular one with soft liner. The patient was checked every two weeks to eliminate any discomfort resulting from an overextension or a pressure area.

Patients' Grouping

Fourteen patients were divided into two equal groups (n=7). Randomization was achieved using randomly generated numbers in an Excel sheet (Microsoft Office). All patients in both groups were rehabilitated with conventional maxillary complete dentures. Bar Clip (BC) group included patients rehabilitated by mandibular over-dentures supported by an implant on one side splinted to a natural canine on the other side and retained by bar clip attachments. Bar Soft Liner (BS) group included patients rehabilitated by mandibular over-dentures supported by an implant on one side splinted to the natural canine on the other side and retained by bar joint attachments utilizing soft liner material.

Definitive prosthetic procedures

For each group of patients, the prosthetic procedures commenced four months following the surgery. The patients were examined clinically to ensure complete healing and periapical radiographs were done to ensure the absence of any radiolucency surrounding the implants. The area surrounding the implant was locally anesthetized by the infiltration technique. The fixture was located by probing. A small crestal incision on top of the cover screw was made to display the implant fixture. The titanium cover screw was unthreaded, and a healing abutment was connected to the implant fixture and left for two weeks.

Primary alginate impression of the mandibular residual ridge was made to obtain a study cast with the healing abutment in position. An auto-polymerizing acrylic resin special tray with an open window over the abutments was constructed on the mandibular cast after being covered by a 2 mm wax spacer. For mandibular impression making, the healing abutment was removed, and the impression transfer coping was screwed into the fixture (Fig. 1B). The tray was checked, impression coping was visible through the window. A plastic post of suitable size was inserted in the prepared post recess of the endodontically treated canine and examined to be parallel with the implant impression coping to be ready for the final impression.

Medium consistency addition silicon (polyvinylsiloxane, Elite HD Regular Body, Zhermack, Italy) impression material was used for making the final mandibular impression. The impression was applied on the fitting surface of the tray and injected around the plastic post to ensure an accurate impression of the prepared post recess. While the impression was seated in the mouth, the transfer coping was detached from the fixture, and the impression, along with the transfer coping and the plastic post, was removed from the oral cavity. The implant analogue was attached and secured onto the impression transfer coping. Extra care was taken not to change the position of the copings in the impression material during manipulation. The implant analogue was surrounded by a thin layer of gingival simulating material (Gingifast Elastic, Zhermack, Italy) before pouring the master model.

The final impression was poured in dental stone, a straight abutment 4.5 mm in length was screwed to the implant analogue then it was reduced in height and prepared to match the prepared natural canine. The bar plastic pattern (OT Bar Multiuse, Rhein 83, Bologna, Italy) was attached to the wax pattern of the copings on the implant abutment and with the post over the canine. The burn out plastic bar was aligned to be parallel to and 2mm away from the residual ridge. The waxed bar was then invested, burned out and cast in chrome cobalt alloy metal. The cast metal bar was tried in its position into the prepared implant abutment and prepared canine in the patient's mouth (Fig. 1 C, D and E).

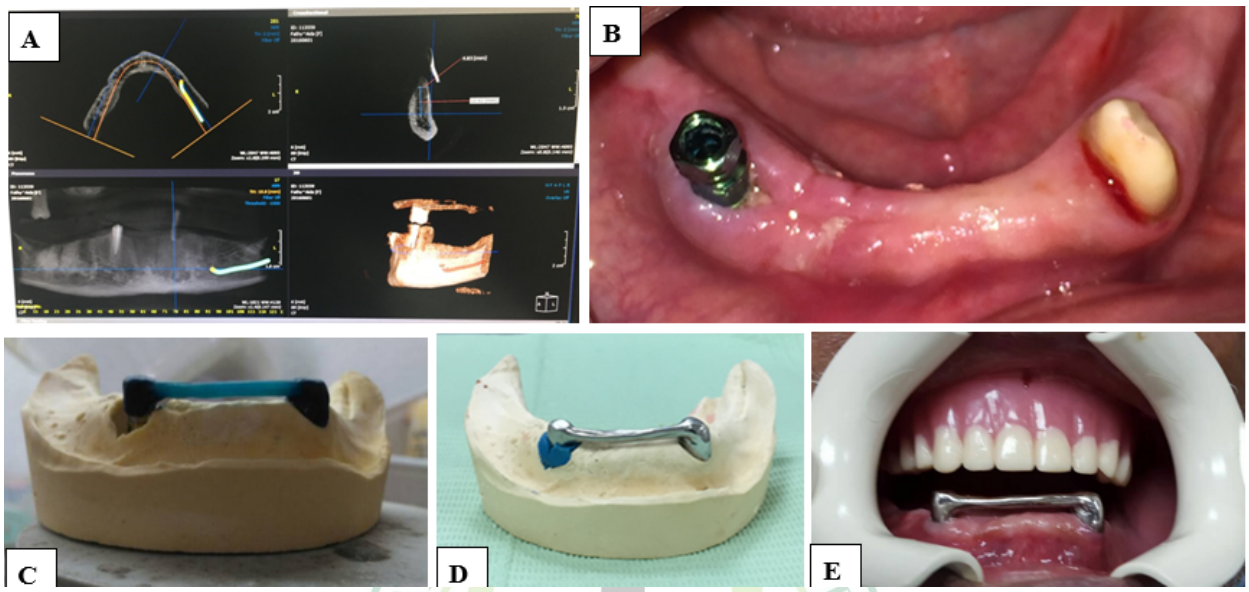

Figure 1 A: CBCT to evaluate the bone dimensions in the implant site, B: Impression transfer coping screwed into the fixture for impression making, C: Bar plastic pattern attached to the copings' wax pattern, D: The cast metal bar, E: The cast metal bar tried in its position intra-orally.

The cast bar was then placed back onto the stone model, and a layer of aluminum foil, approximately 2 mm thick, was applied around and on top of the bar to ensure adequate space for the acrylic resin or soft liner [11]. Mandibular occlusion block was fabricated, jaw relationship was then recorded, and the mandibular over-denture was fabricated in the conventional manner. The bar was cemented (3M Vitremer, Luting Cement, Glass ionomer cement, U.S.A) into the prepared implant abutment and the prepared canine then excess cement was removed.

For the bar clip-retained (BC) group, putty consistency rubber base was used to block out the gap between the bar and the residual ridge. Then, intra-oral pick up of the plastic clip (Retentive Yellow Clip, Medium Retention, Rhein 83, Bologna, Italy) was accomplished using cold cure acrylic resin (Acrostone dental factory Egypt, under license of WHW, England.), while the patient was occluding in the centric relation (Fig. 2A).

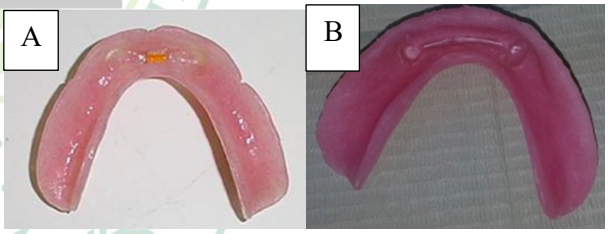

Figure 2 A: For (BC) group, the fitting surface of the mandibular over-denture with the retentive plastic clip, B: For (BS) group, the fitting surface of the mandibular over-denture with the soft liner.

For the soft liner retained (BS) group, a layer of soft-liner adhesive was applied on the fitting surface of the mandibular over-denture and relining was carried out using an addition silicone-resilient liner (GC Corporation Tokyo, Japan) following the closed mouth relining protocol. The mandibular over-denture was taken off followed by trimming of any excess material using a lancet. The glaze base and catalyst were blended and applied to the surface of the soft liner for sealing out of any surface roughness (Fig. 2 B).

The patients received their dentures and strict oral hygiene measures were instructed. Frequent recalls were scheduled for patients' inspection and any necessary adjustments were carried out.

Evaluation methods

Clinical and radiographic evaluation were conducted at the time of denture insertion, six months later and twelve months later for making records to assess the condition of the abutments and their supporting structures.

Gingival Index

The gingival tissue condition of the natural canine and the implant were scored according to *Loe and Silness* and *Apse et al* [14,15]. The gingival health was graded into four grades.

Grade 0: Normal mucosa, no inflammation, no discoloration and no bleeding on probing using blunt probe.

Grade 1: Mild inflammation (slight color change and slight oedema). Mild alteration of the gingival surface, and no bleeding using blunt probe.

Grade 2: Moderate inflammation (redness oedema and glazing) and bleeding on probing using blunt probe or when pressure is applied.

Grade 3: Severe inflammation (marked redness, oedema, spontaneous bleeding and some ulceration).

Four scores were taken at the midpoint of four surfaces: buccal, lingual, mesial, and distal. The average of these four measurements was regarded as the gingival index for either the natural canine or the implant. The average of the gingival indices for both the natural canine and the implant was used as the gingival index for each patient.

Radiographic Evaluation

The differences in the height of the bone were radiographically evaluated and measured using CBCT machine (Scanora3D, Soredex, Finland) after adjusting the control panel for image capturing using the following Parameters: KVp=90 mA=10 Voxel size= 133µm FOV=6*8 cm and exposure time=6.1 s.

Image analysis and measurements

The CBCT images were analyzed utilizing software (On Demand 3D) viewer in panoramic and cross-sectional perspectives. Linear measurements of bone height were taken using the linear measurement tool. Measurements were taken for both natural abutment and implant on panoramic view for mesial and distal measurements and cross-sectional views for buccal and lingual measurements then the bone height differences (in mm) were calculated (Fig 3A and B).

In natural abutments: measurements were taken from the cemento-enamel junction to the crestal bone level.

In implants: measurements were taken from implant apex to crestal bone level.

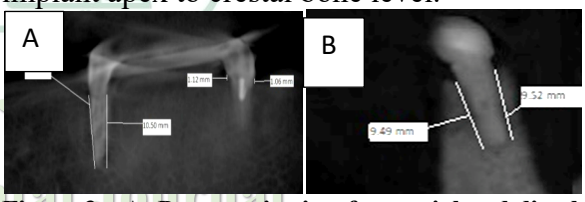

Figure 3 A: Panoramic view for mesial and distal measurements of bone height of the implant and natural canine, B: Cross sectional view for buccal and lingual measurements of bone height of the implant.

Statistical Analysis

Numerical data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Bone height data showed parametric distribution while gingival index (GI) scores showed non-parametric distribution. Repeated measures ANOVA followed by paired T test for pair wise

comparisons were used for bone height data. Mann-Whitney test was used to analyze gingival index data. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® (IBM Corporation, NY, USA.) SPSS® (SPSS, Inc., an IBM Company.) Statistics Version 20 for Windows.

Results

Gingival Index (GI)

Regarding bar clip (BC)group, the base line gingival index score was 0.30, 0.57 after 6 months and 0.57 after 12 months. For bar soft liner (BS) group, the base line gingival index score was 0.43, 0.30 after 6 months and 0.43 after 12 months.

Statistical analysis revealed insignificant difference in the gingival index of the two groups throughout different tested time intervals (table 1).

Table (1): Mean, standard deviation (SD) values and results of Mann-Whitney U test for comparison between Gingival Index (GI) in the two groups.

Time	BC Group (Bar and clip)		BS Group (Bar and soft liner)		*P*-value
	Mean	SD	Mean	SD	
Base line	0.29[a]	0.49	0.43[a]	0.53	0.710
After 6 months	0.57[a]	0.79	0.29[a]	0.49	0.620
After 12 months	0.57[a]	0.98	0.43[a]	0.79	0.902

Means with the same superscript letters are non-significant, significance level was set at $P \leq 0.05$.

Radiographic evaluation of bone height

A. Bone loss at implant site at different intervals during the follow-up period

For bar clip (BC) group, the mean value of bone loss around the implant site (bone height difference) was 1.13 mm from 0 to 6 months, 1.00 mm from 6 to 12 months and 2.13 mm from 0 to 12 months follow-up period. For bar soft liner (BS) group, the mean value of bone height difference was 0.59 mm from 0 to 6 months, 0.69 mm from 6 to 12 month and 1.28 mm from 0 to 12 months follow-up period. Statistical analysis revealed a significant difference in bone loss (bone height difference in mm) at the implant site between BC group (bar and clip) and BS group (bar and soft liner) at different time intervals, where BS group showed a significantly lower mean of bone height difference at implant site compared to BC group (table 2).

Table (2): Effect of different treatment modalities on bone loss (mm) at implant site at different time intervals.

Time	BC Group (Bar and clip)		BS Group (Bar and soft liner)		*P*-value
	Mean	SD	Mean	SD	
0 - 6 m	1.13[a]	0.05	0.59[b]	0.07	<0.001*
6 - 12 m	1.00[a]	0.06	0.69[b]	0.08	<0.001*
0 - 12 m	2.13[a]	0.02	1.28[b]	0.06	<0.001*

***: Significant at $P \leq 0.05$, means with different superscript letters within the same row are significantly different.**

B. Bone loss around natural tooth at different intervals during the follow-up period

On comparing the bone height difference around the natural tooth in the two groups around the natural tooth, it was found that for BC group (bar and clip), the mean value of bone loss was 0.22 mm from 0 to 6 months, 0.46 mm from 6 to 12 months and 0.68 mm from 0-12 months follow-up period. For BS group (bar and soft liner), the mean value of bone loss was 0.10 mm from 0 to 6 months, 0.30 mm from 6 to 12 month and 0.40 mm from 0-12 months follow-up period. Statistical analysis revealed a significant

difference in bone loss (bone height difference in mm) around the natural tooth between BC group (bar and clip) and BS group (bar and soft liner) at the different time intervals where, BS group showed a significantly lower mean of bone height difference around the natural tooth compared to BC group (table 3).

Table (3): Effect of different treatment modalities on bone loss (mm) around the natural tooth at different time intervals.

Time	BC Group (Bar and clip)		BS Group (Bar and soft liner)		*P*-value
	Mean	SD	Mean	SD	
0 - 6 m	0.22[a]	0.03	0.10[b]	0.02	<0.001*
6 - 12 m	0.46[a]	0.03	0.30[b]	0.09	<0.001*
0 -12 m	0.68[a]	0.07	0.40[b]	0.11	<0.001*

***: Significant at P ≤ 0.05, means with different superscript letters within the same row are significantly different.**

Discussion

The sole-standing canine represents a confusing situation as the treatment plan will commonly go for extraction and implant supported over-denture.[5] One of the suggested viable treatment options is the installation of an implant on the other side to provide tooth-implant supported over-denture with subsequent cross arch stabilization and reduction of torque on the single standing natural tooth. It has been recommended to avoid extracting teeth solely to prevent tooth-implant connections, suggesting that connecting teeth and implants is a viable approach for providing support to a prosthesis[6]. Moreover, some researchers supported splinting teeth to implants depending on positive outcomes associated with this treatment modality that showed high levels of patients' satisfaction. Moreover, it has been advocated that splinting an implant to a natural tooth is an affordable and effective solution for treating partially edentulous patients with the advantages of broadening the treatment options, maintaining proprioception and bone volume, offering additional support for force distribution as well as providing less complex treatment with subsequent cost reduction. [7-9]

Accordingly, the current study was conducted to figure out a treatment plan for this sole-standing canine aiming to increase support through splinting to an implant on the contralateral side of the mandible and evaluate the effect of using two different resilient attachment modalities, clip bar attachment and soft-liner attachment on the gingival index and bone height around the implant and the natural tooth.

The selected implant size in this study was of 10.5 mm in length and 3.8 mm in diameter which were considered suitable dimensions to be used in a mandibular ridge of average size[16]. The cornerstone of success in an over-denture treatment lies in the strategic selection of abutments, coupled with endodontic and periodontal therapy, to serve as supporting structures for the over-denture. Preparing abutment teeth to provide ample space for the overlying denture is essential. Shortening the crown enhances the crown-to-root ratio, consequently reducing the mobility of the abutment teeth. [17] In the present study, the mandibular canine was endodontically treated and prepared as dome shaped with 15-degree inclination in all surfaces except the buccal surface with 30-degree inclination, then was reduced in height. Recess for post was prepared using unimetric drilling, and a plastic post of suitable size was used during impression making to fabricate coping retained with post to aid in the retention of the coping due to the short crown length. [18]

The installation of the implants was carried out at intraforaminal area in the canine region that is considered strategic area for supporting and stabilizing an over-denture, and to be in the same location corresponding to the single standing tooth

antero-posteriorly. [19]

In the current study, only one implant was used, splinted to the natural prepared canine with bar in an attempt to distribute the load between the implant, the prepared canine and the mucosa. It has been reported that bar attachments provided superior support and retention, allowed splinting of implants and better distribution of forces. Incorporating clips or resilient liner material on the bar allowed vertical movement of the denture, thus reducing forces on implants and resulting in less crestal bone loss. Due to improved splinting, support, retention, and stability of the bars as compared to solitary attachments, denture extensions could be kept to a minimum with decreased patients' discomfort. [20,21]

The selected natural canine was characterized by having favorable periodontal condition with no mobility to be suitable for splinting to an implant to avoid natural tooth intrusion that has been reported to be the major disadvantage of joining natural teeth to dental implants. [8,9]

The cases were monitored for a duration of 12 months, recognizing that significant bone changes typically occur primarily within the initial year following implant placement. The first evaluation in this study was performed immediately after the over-denture insertion to act as a base line for comparison and evaluation during the follow-up period. [22,23]

Studies have indicated that the gingival index and pocket depth around dental implants serve as indicators of the implant's periodontal condition, reflecting its success or failure. [24, 25] However, previous studies stated that clinical assessment of gingival inflammation alone is not sufficient for dental implant evaluation as it is considered a subjective method that is susceptible to personal variability. Therefore, it was recommended to be further supported by radiographic evaluation of the supporting bone. [26, 27] Measurement of alveolar bone height was done by CBCT at the buccal, lingual, mesial, and distal sides to evaluate the amount of bone loss at each implant neck [28]. This measurement was done using (On Demand 3D) software viewer in panoramic, cross-sectional and three-dimensional views to get the most accurate results.

It has been advocated that implant retained over-denture patients have to be motivated for adequate cleaning of the denture, with special care given to those areas that are at higher risk for plaque retention, such as the concave areas around the retentive devices and the undercuts. [29] Therefore, patients were instructed to use interproximal brushes to clean the proximal spaces and the gingival side of the bar.

The gingival status results indicated minimal signs of inflammation in both groups. This could be attributed to the hyperplasia of gingival tissues under the bar and around the abutments, as they attempt to fill in the gaps between the denture, bar, and abutments. This result agreed with the results of other studies that reported observation of hyperplasia around dental implants in about 25% of the cases. However, in this study, slight hyperplasia was observed in both groups, likely due to the strict oral hygiene instructions provided to the patients aiming to control plaque accumulation around implants and natural teeth. Furthermore, great care was given by the prosthodontist to avoid excessive relief of the fitting surface of the denture to avoid increased hyperplasia of the gingival tissues. [30, 31]

Moreover, clinical, microbiological, and histological studies on humans with implant- and tooth-supported prostheses reported favorable histological findings in the surrounding soft tissues of both the tooth and implant, with minimal inflammatory cell infiltrates, if any, and good bone-implant contact. [32]

The radiographic results of this study showed significant bone loss around both implant and natural tooth in BC group (bar and clip) compared to BS group (bar and soft liner). According to the findings of the present study, the initially proposed null hypothesis was rejected as it was found that resilient liner attachments significantly reduced bone loss over time during the follow-up period compared to clip attachments. These results could be explained based on several reasons. First, soft liner attachments reduce trauma, provide a cushion like effect, and increase blood supply to peri-implant tissues. Second, surface porosity and roughness of resilient liners were sealed by the glazing material used, thus minimizing the adhesion of candida and micro-organisms and favors plaque removal.[33,34] Third, the soft-liner female housing continuously cleans the bar and abutments during denture insertion and removal, preventing plaque accumulation regardless of the patient's oral hygiene practices. [11,35]

Moreover, resilient liner housing fully seals the space around the bar and partially seals the space beneath it, thereby minimizing plaque and microbial adhesion that could lead to inflammation of the peri-implant tissues, bone resorption, and pocket formation. [10] In addition, the shock-absorbing capability of the soft liner reduces the stress exerted on the implants, thereby decreasing peri-implant bone loss. Additionally, the existence of soft liners compensates for any acrylic resin shrinkage that might happen during laboratory processing of the denture. This prevents direct contact between the implants, the bar and the acrylic resin, thereby reducing the risk of implant overloading. [11, 35-37]

The compromised peri-implant tissue response to clip attachment may be attributed to mechanical as well as biological factors. Mechanical factors include trauma to peri-implant tissues due to over-denture rotation around the bar and the mechanical leverage produced by over-dentures retained by clips, which tightly grasp the bar anteriorly. This transmission of functional load to the implants contributes to more bone loss. [36-38] Biological factors may result from unsealed free spaces within the denture base surrounding the bar and abutments. While these spaces allow for rotation of the over-denture around the bar, they also create sheltered areas favorable for microbial colonization and plaque accumulation.[35,39] Furthermore, reports suggest that clip-retained over-denture wearers find it challenging to maintain adequate oral hygiene, particularly in the areas around the abutments and beneath the bar. [40]

Conclusions

Considering the limitations of this study, it could be concluded that:

1. The use of clip or soft liner for retaining mandibular over-dentures did not alter the gingival index around the implant and the natural tooth.
2. Soft liner retained over-dentures had a valuable effect on decreasing bone resorption around the implant and natural tooth compared to the clip retained over-dentures.
3. The use of one implant at the canine area splinted to natural abutment could be considered an acceptable conservative treatment modality.

References

1. Una Soboleva & Irena Rogovska . Edentulous patient satisfaction with conventional complete dentures: Medicina 2022, 58, 344.

2. Abraham P, Koka P, Murugesan K, Vasanthakumar M. Telescopic overdenture supported by a combination of tooth and an implant: A Clinical Report. Journal of Indian Prosthodontic Society. 2010 (4):230–233.

3. Bansal, S., Aras, M. A., & Chitre, V. Tooth supported overdenture retained with custom

attachments: A case report. Journal of Indian Prosthodontic Society, 2014 (1): 283–286.
4. Al-Harbi FA. Mandibular implant-supported overdentures: Prosthetic overview. Saudi Journal of Medicine & Medical Sciences. 2018 Jan 1;6(1):2-7.
5- Molinero-Mourelle, P., Bischof, F., Yilmaz, B., Schimmel, M., & Abou-Ayash, S. Clinical performance of tooth implant-supported removable partial dentures: a systematic review and meta-analysis. Clinical oral investigations. 2022, 26(10), 6003–6014.
6-Lindh T. Should we extract teeth to avoid tooth-implant combinations? *J Oral Rehabi*. 2008; 35 (1):44–54.
7-Taneja S, Khalikar A, Wankhade S, Deogade S, Uchale P, Lalsare S. Survival of tooth-implant connections: A systematic review and meta-analysis. J Indian Prosthodont Soc. 2023;23(4):310-321.
8-Syam Kumar S J, Anjali G Pai. Implants splinted to natural teeth- a review. The journal of Prosthetic and Implant Dentistry .2021; 4(3):133-139
9-Al-Omiri MK, Al-Masri M, Alhijawi MM, Lynch E. Combined implant and tooth support: An up-to-date comprehensive overview. Int J Dent. 2017; 2017:6024565.
10- Moustafa Abdou ELsyad; Soft liner/clip attachment for bar-retained implant overdentures: A technical note. J Oral Implantol .2016; 42 (5): 442–445.
11- Elsyad MA, Shoukouki AH. Resilient liner vs. clip attachment effect on peri-implant tissues of bar-implant-retained mandibular overdenture: a 1-year clinical and radiographical study. Clin Oral Implants Res. 2010;21(5):473-80.
12-Kiat-Amnuay S, Khan Z K, Gettleman. Overdenture retention of four resilient liners over an implant bar. J Prosth Dent. 1999; 81: 568–573.
13- Rizk,Fardos N. Comparative evaluation of two different castable bar attachments in implant retained mandibular overdenture cases . Egypt. Dent. J. 2013;59:2463-2472
14-Loe, H. and Silness, J. Periodontal disease in pregnancy. Prevalence and severity. Acta Odont. Scand.1963; 21: 533.
15-Aspe, P.; Zarb, G. A.; Schmitt, A. and Lewis, D. W.: The longitudinal effectiveness of osseointegrated dental implants the Toronto Study: Peri-implant mucosal response. Int. J. Periodontics Restorative Dent.1991; 11: 95.
16- Kang SH, Kim SK, Heo SJ, Koak JY. Survival rate and clinical evaluation of the implants in implant assisted removable partial dentures: surveyed crown and overdenture. J Adv Prosthodont. 2020 Aug;12(4):239-249.
17-Guttal SS, Tavargeri AK, Nadiger RK, Thakur SL. Use of an implant o-ring attachment for the tooth supported mandibular overdenture: a clinical report. Eur J Dent. 2011; 5:331.
18-Almuhaiza M. Fracture resistance of three different post and core systems on endodontically treated teeth: an in vitro study. J Int Oral Health. 2016; 8:679.
19- Warreth, Abdulhadi & Byrne, Caroline & Alkadhimi, Aslam & Woods, Edel & Sultan, Ahmed. Mandibular implant-supported overdentures: attachment systems, and number and locations of implants--Part II. Journal of the Irish Dental Association 2015; 61: 93-97.
20-Luthra R, Sharma A, Kaur P. Implant supported overdenture: A case report. Periodon Prosthodon. 2016, 2:2.
21-Sahar KH. Abdel-Bary .Comparative evaluation of mandibular overdenture with single canine splinted or unsplinted to implant on the abutment supporting structures . Egypt. Dent. J. 2020; 66:1123-1131.
22- Doaa Mahmoud El Kady, Islam Shawky Mohamed Shaker. Radiographic evaluation of alveolar bone height changes around mandibular implants with different surface treatments supporting mandibular overdenture (a split mouth comparative study). Egypt. Dent. J. 2024; 70:531-541.
23- Amr Salah El Din Gomma, Omayma Ahmad Mohamad, Sara Maher Shaaban. Evaluation of marginal bone height changes in implant supported mandibular overdenture retained with two different materials of bar attachments. Egypt. Dent. J. 2024; 70:519-530 .
24- Scarano, A.; Khater, A.G.A.; Gehrke, S.A.; Serra, P.; Francesco, I.; Di Carmine, M.; Tari, S.R.; Leo, L.; Lorusso, F. Current status of peri-implant diseases: A clinical review for evidence-based decision making. *J. Funct. Biomater.* 2023, *14,* 210.
25- Pathak AK, Goel K, Shakya V, Tiwari AK. Periodontal parameters around implants and natural teeth. Natl J Maxillofac Surg. 2016;7(1):52-55.
26- D. Clark-Perry, G.A. Van der Weijden, W.E.R. Berkhout, T. Wang, L. Levin, D.E. Slot.
Accuracy of clinical and radiographic measurements of periodontal infrabony defects of diagnostic test accuracy (DTA) studies: a systematic review and meta-analysis. Journal of Evidence-Based Dental Practice 2022;22(1):10166
27- Nagarajan, A., Perumalsamy, R., Thyagarajan, R., & Namasivayam, A. Diagnostic imaging for dental implant therapy. Journal of clinical imaging science. 2014; 4(Suppl 2): 4.

28-Goyal, M. K., Goyal, S., Garg, S. K., Mehendale, A. V., Hegde, A. V., & Kumar, N. (2022). CBCT based assessment of crestal bone loss in patients treated with mandibular implant over dentures: An original research study. International Journal of Health Sciences 2022; 6(S4), 6038–6044.

29-Jiménez – Lopez.Oral Rehabilitation with Implant–supported Prostheses. Quintessence Publishing Co, Chicago, Berlin, London.2000; 136-288.
30-Burns DR. Mandibular implant overdenture treatment: Consensus and controversy. J Prosthodont. 2000; 9:37-46.
31- Sánchez-Torres, A., Mota, I., Alberdi-Navarro, J., Cercadillo-Ibarguren, I., Figueiredo, R., & Valmaseda-Castellón, E. Inflammatory fibro-epithelial hyperplasia related to a fixed implant-supported prosthesis: A case report. Journal of clinical and experimental dentistry.2018;10(9): 945–948.
32-Trisi P, Keith D J, Rocco S. Human histologic and histomorphometric analyses of hydroxyapatite-coated implants after 10 years of function: A case report. *International Journal of Oral and Maxillofacial Implants.* 2005*;* 20(1):124–130.
33-Sesma, N, Lagana D C, Morimoto S Gil C. Effect of denture surface glazing on dental plaque formation. Brazilian Dental Journal.2005; 16:129–134.
34-Olan-Rodriguez, L, Minah G E, Driscoll C F. Candida albicans colonization of surface-sealed interim soft liners. J of Prosth. 2000;9: 184–188.
35-Salama A, Hany Ibrahim Eid, Shaimaa Lotfy Mohamed Ouda. Effect of implant supported overdenture with different bar attachment modalities on the implant and overdenture supporting structures Ain Shams Dental Journal, 2019; 22: 181-188.
36- Samy O, Mahmoud Hassan El Afandy, Shaimaa Lofty Mohamed. Effect of resilient soft liner and clip attachments on peri-implant tissue in splinted mini-implant retained mandibular overdentures. Ain Shams Dental Journal, 2021; 24(4): 109-121.
37- Amr Salah El-Din, Ahmed M. Osama Ahmed Shawky. Evaluating the influence of different soft liners retaining mini implant supported mandibular over denture on the marginal bone height. Egypt. Dent. J. 2019; 65:1549-1558
38-Heckmann S M, Schrott A, Graef F, Wichman. Mandibular two-implant telescopic overdentures. 10-year clinical and radiographical results. Clin Oral Impl Res.2004; 15: 560–569.
39-Lachmann, S, Muller E, Gehring K, Axmann D. A comparison of implant supported bar or ball retained mandibular overdenture; A retrospective clinical, microbiological and immunological study. Int J prosthodont. 2007; 20: 37–42.
40- Zhou, H., Jiao, Y., Ma, C. F., Wang, C., Zhao, S. J., Tian, M., Tay, F. R., & Chen, J. H. Clinical outcomes of implant-retained mandibular overdentures using the bar and magnetic attachment systems: an up to 5-year retrospective study. Annals of translational medicine.2020; 8(21):1360.